

**ABSTRACT:**

[0096] Fabrication apparatus and methods are disclosed for shaping and finishing difficult materials with no subsurface damage. The apparatus and methods use an atmospheric pressure mixed gas plasma discharge as a sub-aperture polisher of, for example, fused silica and single crystal silicon, silicon carbide and other materials. In one example, workpiece material is removed at the atomic level through reaction with fluorine atoms. In this example, these reactive species are produced by a noble gas plasma from trace constituent fluorocarbons or other fluorine containing gases added to the host argon matrix. The products of the reaction are gas phase compounds that flow from the surface of the workpiece, exposing fresh material to the etchant without condensation and redeposition on the newly created surface. The discharge provides a stable and predictable distribution of reactive species permitting the generation of a predetermined surface by translating the plasma across the workpiece along a calculated path.